048 Hold Adaptor for Voltmeters

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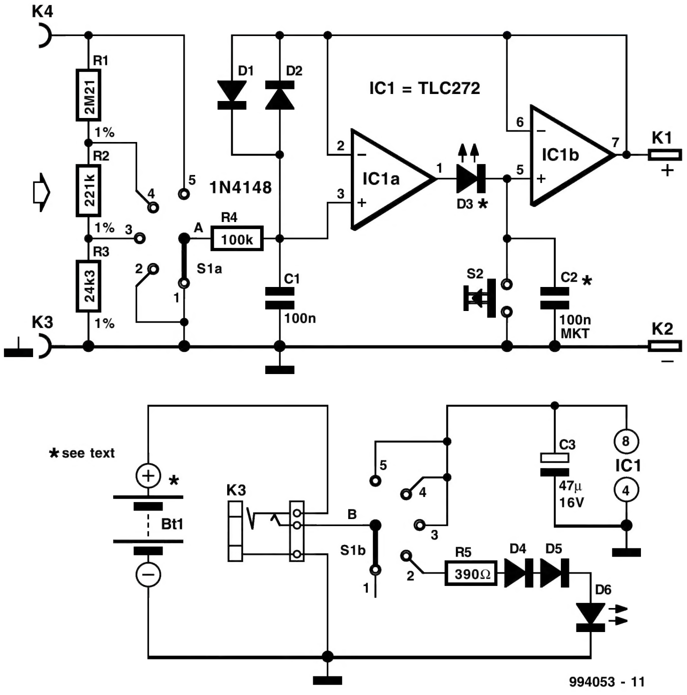
Modern, good-quality multimeters have a hold function that enables a measurand to be read even after the test prods have been removed. The present adaptor is intended to add this facility to multimeters and voltmeters that are not so equipped.

In meters with a hold function, the measurand is quantized by an analogue-to-digital converter (ADC) and held in memory. This type of hold function is fairly sophisticated, but for can be attained by a rather less expensive and simpler analogue circuit.

A hold function is invariably based on a capacitor that is charged to the full value of the measurand. The resulting voltage across the capacitor is used to drive the display. In the case of analogue memories a variety of phenomena may affect the reading and lead to errors. Also, the charge on the capacitor does not remain constant owing to self-discharge, leakage currents on the board, the input current to a measurement amplifier, and so on. These deficiencies can, however, be negated by the use of a capacitor with a very high insulation resistance, a customized board layout, a current operational amplifier (op amp) with an input impedance in the region of teraohms.



The discharge current of a capacitor cannot be controlled properly by a silicon diode: it is far better to use a light-emitting diode (LED) that is totally screened, so that no light can escape. The photo current is then reduced from a few nA to some pA. This property of LEDs has been known for may years, but is hardly ever used for practical purposes. As an illustration, in the prototype the output voltage had dropped by only 1%, from 1.000 V to 0.990 V, thirty minutes after the original measurement was taken.

The circuit is simplicity itself as is evident from the diagram. In this type of circuit, the potential divider at the input is unavoidable. Here, the divider is arranged to measure input voltages of 2 V, 20 V, and 200 V: the voltmeter connected to the output remains set to the 2 V range.

The divider is followed by low-pass filter $R_{4\text{-}C}1$ which decouples the op amps from any noise and interference on the input signal. Resistor R_4, in conjunction with diodes D_1 and D_2, provides overvoltage protection.

The two op amps are arranged as voltage followers. Diode D_3 is the earlier mentioned screened LED, while C_2 is the reservoir capacitor with a very high insulation resistance. The potential across C_2 is applied to the non-inverting input of IC_{2b}. The low-impedance output of this voltage follower allows the use of a analogue pointer voltmeter or multimeter. Note that C_2 is shunted by miniature push-button switch S_2, which enables the capacitor to be discharged instantly when required.

Switch S_1 serves not only as input selector, but also as on/off switch (position 1), and enables the supply voltage to be monitored (position 2). In conjunction with diodes D_4 and D_5, light-emitting diode D_6 lights only when the supply voltage <2.8 V.

The supply voltage may be derived from a 3.6 V Li-ion battery, a 9 V size PP3 dry or rechargeable battery, or a mains adaptor. The current drawn by the hold adaptor is small: in the quiescent mode <1 mA, and in the absence of a hold voltage about 0.2 mA. The specified value of R_5 is right for supply voltages up to 5 V; when a 9 V battery or mains adaptor is used, the value should be increased to 1.2 kΩ.

When set to positions 3–5, switch S_1 functions as input selector. Diode D_6 is then not in operation.

Only good-quality components should be used. Diode D_3 is a standard (not high-efficiency) red LED, which has been dipped a couple of times in black lacquer, but it can also be made light-tight with good-quality black insulating tape. Its terminals should also be well insulated to prevent leakage currents. The IC should be placed in a good-quality suitable socket. If a board is used, make sure that it is very clean (use pure alcohol) and free of any smudges such as fingerprints or handprints. When the construction work has been completed, it is beneficial to spray the track side with a good insulating lacquer. This will reduce the risk of leakage current sand also keep the tracks clean and free from corrosion.

The adaptor need not be calibrated. After it has been switched on and after every measurement, press S_2 for about a second to make sure that capacitor C_2 is thoroughly discharged. Even then, an offset voltage of 2–3 mV may be measured. However, this is of no consequence, as long as the measurand is higher than this potential.

In principle, the circuit may also be used for measuring alternating voltages: the value of C_1 must then be reduced to about 0.001 µF, which gives an upper limit of 1000 Hz. Owing to the high input resistance and to prevent stray voltages from interfering with the measurement, the input sockets should be replaced by a BNC socket. Owing to the asymmetric supply voltage, the IC, in conjunction with D_3, forms a peak-voltage rectifier. This means that with a sinusoidal input signal, the output of the hold adaptor is ×1.414 higher than the r.m.s. value of the input signal.

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